

China Experience in Renewable Energies

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Received: 09/05/2022

Accepted: 08/06/2022

Published: 16/06/2022

Abstract:

The natural capacities available from new and renewable energy sources as well as policies to improve energy efficiency play key roles in energy sustainability, provided that the resources are used according to their technical and economic feasibility in implementing a set of policies that take into account the social and economic aspects. With the creation of convictions reflected in the need to preserve available energy resources and reduce environmental pollution, and this is what we will try to address through this research paper by studying one of the leading countries in the field of renewable energies: China.

Keywords: Renewable Energies, Renewable Energy Sources, Solar Energy, Hydroelectric Energy, Renewable Energy Financing in China.

Jel Classification Codes: K32, N55, N75, O13, O14.

1. INTRODUCTION

Energy is an essential component of the universe and is considered a form of existence. Energy is usually derived from natural and other abnormal sources, so it is divided into two main types, namely: renewable energy, which depends on natural sources, and other non-renewable energy, and depends on abnormal sources, but it was formed with time and under the influence of a set of factors. All types of this energy require the existence of

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special mechanisms, tools and techniques to extract it and harness it for the benefit of man.

China has been working for decades to adopt a new energy model that responds to the requirements of sustainable development, by going into the investment experience in developing renewable energies, which allows achieving the goals of its energy policy aimed at diversifying the energy formation, in addition to its contribution to providing energy services in remote areas. At the international level, diversification of energy sources through reliance on renewable energies in response to current global environmental concerns.

1.1 Problem

From above, the following problem can be formulated:

How did China develop renewable energies?

1.2 Sub-questions

Through this question, some sub-questions can be drawn:

- What is meant by renewable energies?
- What are the factors that helped China to develop renewable energies?

1.3 Hypotheses

To address the previous problem and the questions that branched from it, we define some hypotheses as points to address our search this:

- The economic policies implemented in China have helped to develop the renewable energy sector
- Factors for the success of the renewable energy sector in China are due to the strategies adopted

In order to answer the previous problem, the topic deals with generalities on renewable energies in one side and the China's experience in developing renewable energies in the other side.

2. Generalities on renewable energies

Renewable Energy is a type of energy that is inexhaustible and does not run out, and its name indicates that whenever it is nearing completion, it resides again, and its source is one of the natural resources, such as wind, water, and the sun, and the most important characteristic of it is that it is clean and environmentally friendly energy, as it does not leave behind Gases are

harmful, such as carbon dioxide, and do not affect the environment around them. They do not play a role that affects the temperature level. The sources of renewable energy are completely in contradiction to their non-renewable sources, such as natural gas and nuclear fuel, as these sources lead to global warming and the release of carbon dioxide when used. In light of the importance of renewable energy, a new type of business has recently emerged under the name of the renewable energy trade, and most of its work has focused on harnessing renewable energy sources and exploiting them as a source of income and material benefit, through promoting them, despite what is wrong with them how Exploiting renewable energy from a high cost and not providing the necessary mechanisms and technologies sufficiently, but there are a large number of countries that are preparing to start investment projects for renewable energy, while making sure to draw the dimensions of the policies of these projects, and work to develop and develop them. (Jenny Corry, 2017)

3. The advantages of renewable energy

There are a set of advantages that renewable energy enjoys, which make it a distinct source of energy, the most important of which are: (Finance, 2014)

- Renewable energy is well present in all parts of the world.
- Renewable energy is environmentally friendly and clean.
- They are available permanently and are renewable again.
- It is easy to use by using simple techniques and mechanisms.
- It is very economical energy.

It is considered an important factor in environmental and social development, in all fields.

- It helps to create new job opportunities.
- It helps to reduce the emissions of gaseous and thermal emissions.
- Prevents acid rain harmful.
- It reduces the accumulation of waste in all its forms.
- Leaving the crops free of chemical pollutants, thus increasing agricultural productivity.
- It uses uncomplicated technologies and can be manufactured locally in developing countries.

4. Types of renewable energies

Renewable energy comes from several sources, which have different types, and can be divided into several categories as follows:

4.1 Solar energy

The sun is one of the largest sources of light and heat on the face of the earth, and this energy generated by the nuclear fusion reactions inside the sun is distributed over the parts of the earth according to its proximity to the equator, and this line is the region that has the largest share of that energy, and the thermal energy generated by sunlight. (REN, 2017)

Solar energy means the light emitted and the heat produced by the sun, which has been harnessed by humans for its benefit since ancient times using a range of technology that is constantly evolving. Most of the renewable energy sources available on the surface of the Earth are due to solar radiation in addition to secondary energy sources, such as wind, wave, hydroelectric, and biomass ... It is important here to mention that only a small portion of the solar energy available in our lives has been used.

4.2 Wind energy

It is an energy that is defined as the process of converting the movement (energy) of the wind into another form of energy that is easy to use, usually electric, by using turbine helicopters. The movement of the winds that spin the turbines is transformed by converting the rotation of the wind into electricity by generators. Wind energy has many uses, notably:

Pumping water with wind pump power. Wind irrigation pumps are common in Australia, parts of Africa, Asia, and Latin America. Wind energy may soon be used to generate electricity on farms and homes, at a lower cost than fuel.

Moving ships and pushing their sails. It is characterized by being completely reliable as a good alternative to fossil fuels, and it is always available and constantly renewed, and it is considered one of the cleanest and environmentally friendly sources of energy. (Gabriel Elizondo Azuela, 2014)

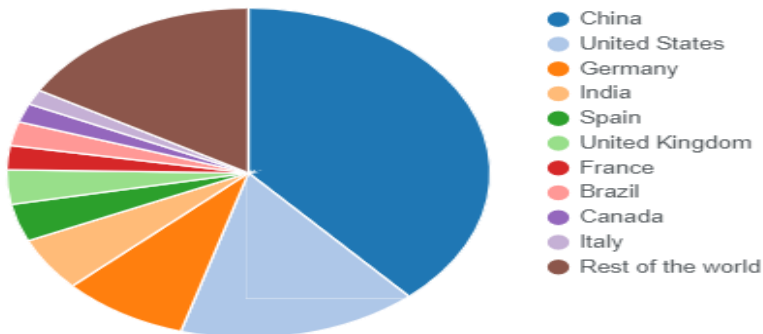
Table 1. Leading countries in wind energy production (2021)

Ranked	Country	The country total energy End of 2021 (GW)
1	China	221
2	USA	96.4
3	Germany	59.3
4	India	35
5	Spain	23
6	United Kingdom	20.7
7	France	15.3
8	Brazil	14.5
9	Canada	12.8
10	Italia	10

Source: <https://www.evwind.es/2021/05/24/top-10-countries-in-wind-energy-capacity/80896>

Top 10 countries by cumulative wind capacity in 2020 :

Fig.1. Top 10 countries by cumulative wind capacity in 2020



Source: [Global wind statistics, 2020](#)

4.3 Nuclear Energy

Nuclear energy is energy that is released during the fission or fusion of atomic nuclei. Nuclear energy accounts for 20% of the energy generated in the world. Scientists view nuclear energy as a true, inexhaustible source of energy. What raise some opposition about the future of nuclear energy is

the high costs of building reactors, public safety concerns and the difficulty of disposal. (Richard Bridlem, 2014)

4.5 Hydroelectric power

The term hydroelectric is a comprehensive term for both electricity and water. This type of energy is used in the exploitation of water energy to generate electrical energy, and it is considered a very clean energy, with a widespread. In the process of exploiting this energy, it is completely dependent on the energy inherent in the water, or the energy of the situation, and converting it into kinetic energy through the fall and flow of water from top to bottom, so that the generation turbines are managed.

One of the most important advantages of using hydropower is that it is environmentally friendly, and the capital spent in this process is to build a dam or reservoir, and this is useful in the process of regulating irrigation, as well as generating electricity, as it does not need high costs for maintenance operations, and water turbines are easy to install And play. Water has been a source of energy for many centuries. It was old used to move flour mills and grains, pumped water and pushed it into fountains. The most important forms of exploitation of water energy are the following:

- Irrigation canals
- Tidal Energy.
- Energy of waves.
- Tidal current energy.

4.6 Hydropower

Water energy is energy that is derived from the continuous movement of water and which cannot be exhausted. It is one of the most important sources of renewable energy, in other words, it is benefiting from the movement of water for beneficial purposes. It was the use of hydropower before the spread of commercial electric power in irrigation, grain milling, and the textile industry.

4.7 Bioenergy

It is the energy derived from living organisms, whether plant or animal. It is one of the most important sources of renewable energy, unlike other natural resources such as oil and coal.

4.8 Ground energy

It is the energy of the geothermal, where it takes advantage of the rise in temperature in the earth's cavity by extracting this energy and transferring it to other forms, and in some areas of cracks and cracks the groundwater leaks through the cracks and cracks to great depths so that it touches areas of very hot and heated up and rise to the top of the hot effervescent, and some These springs erupt and worm several times an hour, and some flow continuously and smoothly, bringing with it dissolved minerals from the deep rock layers. This shows what are called hot springs, in addition to other projects.

4.9 Tidal Energy

Tidal energy or lunar energy is a type of mechanical movement energy that is stored in the currents resulting from the tides that naturally result from the gravity of the moon and the sun and the rotation of the Earth around its axis and therefore this energy is classified as renewable energy.

5. Benefits of renewable energy

The benefits of renewable energy are multiple according to the field in which they are used, and the most important of them are:

- **The military field:** The most important applications for renewable energy in the military field, which can be used to facilitate life in new military cities, include:

- The solar heating system of military colleges, in order to meet the needs of students.
- Supplying the units with hot water, by using field solar heaters. Water desalination.
- Fixed wireless station feed.

5.1 Domestic commercial field: Renewable energy is of great importance in the life of the population, and its most important household uses are:

- Heating water for use in the purposes of cleaning, bathing, and washing, using solar collectors, and without converting it to any other form of energy and is the cheapest type of energy completely.
- Solar water heating by using the absorbent solar surface.

5.2 The agricultural field: There are multiple uses of renewable energy in agricultural use, the most important of which are:

- Drying agricultural products.
- Solar greenhouses.

5.3 Industrial field:

- Distillation and water desalination.
- Charge the batteries at the TV and wireless booster stations.
- Illumination of waterways.
- Navigational alarms.
- Speaker System.
- Charging the electric batteries.
- Electricity generation in remote villages.

In addition, there are other points

- Generating energy that produces no greenhouse gas emissions from fossil fuels and reduces some types of air pollution
- Diversifying energy supply and reducing dependence on imported fuels

Creating economic development and jobs in manufacturing, installation, and more.

6. China's experience in developing renewable energies

This axis will be covered through the following points: (EY, 2017)

6.1 An overview of renewable energies in China and some countries around the world

The amount of investment in renewable energies varies among countries, depending on the type of energy the country is interested in extracting from the renewable resources available to it, the least expensive and the most capable of generating energy. (Agency, 2018)

China is a world leader in the production of renewable energy from wind, solar energy and biofuels worldwide. The growth in these sectors has increased as a result of the correct policies pursued by the Chinese government. China is currently facing great challenges, namely, that China occupies the first place in greenhouse gas emissions at the global level, and that China is still dependent on power generation on coal and oil,

accounting for 90% of the amount of energy consumed in China. China's road towards sustainable energy continues to improve the living and environmental standard of the Chinese citizen, as shown in Table (2):

Table 2. The Top 10 countries Energy Transition Investment by Country

Country	2021 Energy Transition Investment (US\$)	% of World Total
China	\$266B	35.2%
U.S.	\$114B	15.1%
Germany	\$47B	6.2%
U.K.	\$31B	4.1%
France	\$27B	3.6%
Japan	\$26B	3.4%
India	\$14B	1.9%
South Korea	\$13B	1.7%
Brazil	\$12B	1.6%
Spain	\$11B	1.5%
Total	\$561B	74.3%

Source: Govind Bhutada, Energy Transition Investment Report, Top 10 countries in 2021, February 7, 2022

Through Table 2, we note that China ranks first in investment in most types of renewable energies (renewable energies except for water, hydroelectric, solar, wind, and solar water heating, biodiesel), while competing in first place in South Africa and MMA is investing in concentrated solar energy and producing ethanol fuel, respectively, for China to come second and third respectively.

As for Table 3, it represents the leading countries in the production of renewable energies:

Table 3. The five leading countries in the field of renewable energy production

Annual investment / net additional capacity / year production 2016					
Investing in renewable energies Including hydropower	1	2	3	4	5
	China	USA	Brazil	Germany	Canada
Investing in renewable energies Except hydropower	China	USA	Germany	Japan	India
Vital energy	USA	China	Germany	Brazil	Japan
Hydroelectric power	China	Brazil	USA	Canada	Russia
Concentrated solar power	Spain	USA	India	South.Africa	Morocco
solar energy	China	Japan	Germany	USA	Italia
Wind Energy	China	USA	Germany	India	Spain
Solar water heating power	China	USA	Turkey	Germany	Brazil
Ground heating energy	China	Turkey	Japan	Island	India

Source : Renewables, 2017 Global Status Report », REN 21, p25

China ranks first in most products (renewable energies including water energy and without water energy), while it is not ranked among the countries producing concentrated solar energy and ranks second in the generation of bioenergy after the United States of America. (BTM Consult, 2012)

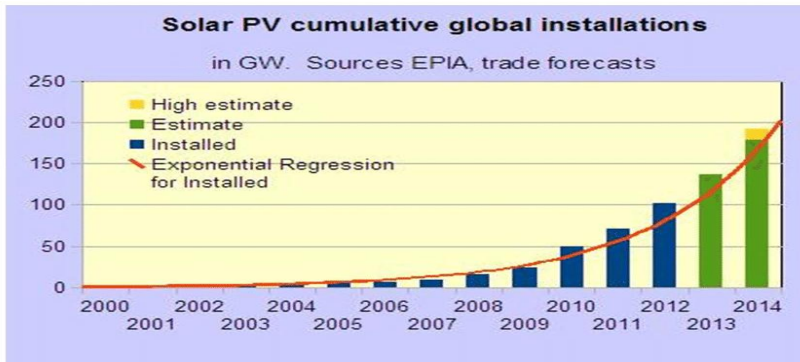
6.2 China's road to renewable energies

China has a great distinction in the field of investment and production of renewable energies, compared to the rest of the world, where the proportion

of investment in it was rapid in the period between 2000-2014, as the ratio increased from year to year.

This is what the following form represents:

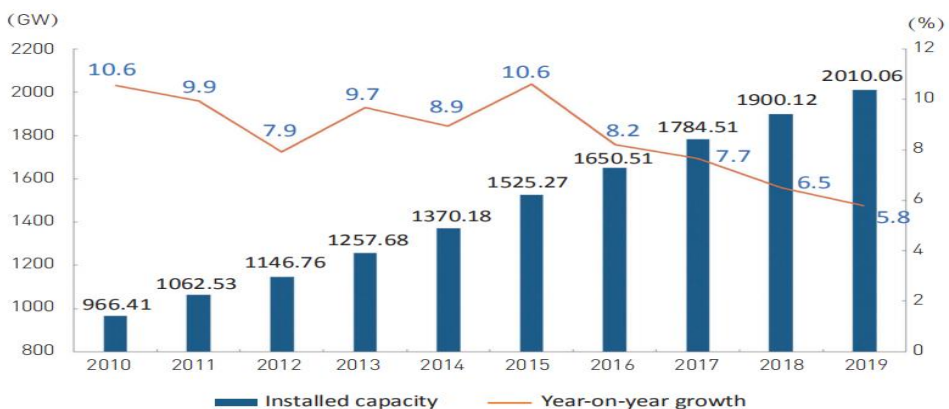
Fig.2. Solar cells in China



Source: EPIA, Trade for Casts, 2015

China became the largest country in the world producing solar energy equipment in the period (2006-2011), and the photovoltaic modules (PV) units flourished in the world in European countries such as Germany, Spain and Italy, which led to adding about 27.7 GW of energy to the total amount of energy in the year 2011 as the global production amounted to 67.4 GW of solar cells, compared to 7.3 GW in 2006 as shown in the above figure. (EPIA, 2015)

Fig.3. Total Installed Generation Capacity and Growth in China (2013-2018)

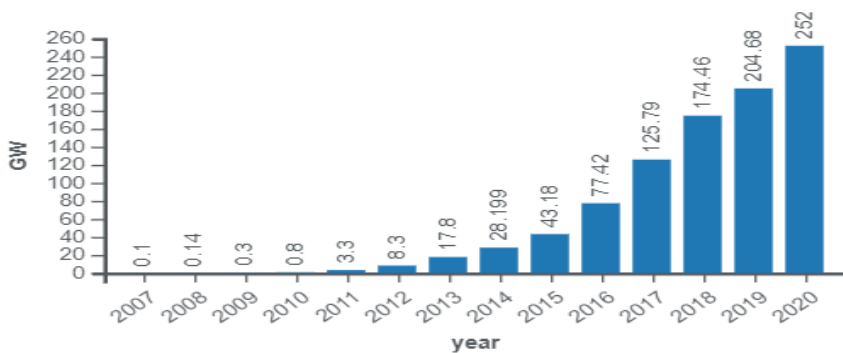


Source: China Renewable Energy Industry Development Report 2020; National Energy Agency.

At the beginning of 2020, Chinese domestic solar developers were riding a high after reaching a record 53 GW of newly installed solar capacity the previous year. Most sources projected this breakneck pace of new solar construction would continue through 2018.

Over the months, solar component prices dropped to record lows, both utility-scale and distributed projects stalled, and lower tier companies collapsed. However, the government intentions were clear—decrease reliance on subsidies, improve product quality, and complete the shift towards marketization. Despite the setbacks, the Chinese solar industry succeeded in installing 44 GW of new capacity by the end of 2018 (Figure 3).

Fig.4. China Cumulative installed PV capacity in gigawatts (2007 – 2020)



Source: Shukla, Harsh (21 January 2021). "China Adds 48.2 GW of Solar Capacity in 2020, its Second Best Year on Record". Mercom India. [Archived](#) from the original on 21 January 2021. Retrieved 6 June 2021.

China is the largest market in the world for both photovoltaics and solar thermal energy. China's photovoltaic industry began as development for space satellites and transitioned to domestic energy use in the late 1990s. After heavy government incentives introduced in 2011, China's solar power market grew dramatically, becoming the leading installer in the world for photovoltaics in 2013. In 2015, China surpassed Germany as the world's largest producer of photovoltaic energy and became the first country to have over 100 GW of total installed photovoltaic capacity in 2017. At the end of 2020, China's total installed photovoltaic capacity was 253 GW, accounting for one-third of the world's total installed photovoltaic

capacity (760.4 GW). Most of China's solar power is generated within its western provinces and is transferred to other regions of the country. In 2011, China owned the largest solar power plant in the world at the time, the Huanghe Hydropower Golmud Solar Park, which had a photovoltaic capacity of 200 MW. In 2018, it held the record again with the Tengger Desert Solar Park with its photovoltaic capacity of 1.5 GW. China currently owns the second-largest solar plant in the world, the Huanghe Hydropower Hainan Solar Park, which has a capacity of 2.2 GW. Solar power contributes to a small portion of China's total energy use, accounting for 3.5% of China's total energy capacity in 2020.

6.3 China's five-year plans for investment and renewable energies

- The Tenth Five-Year Plan:

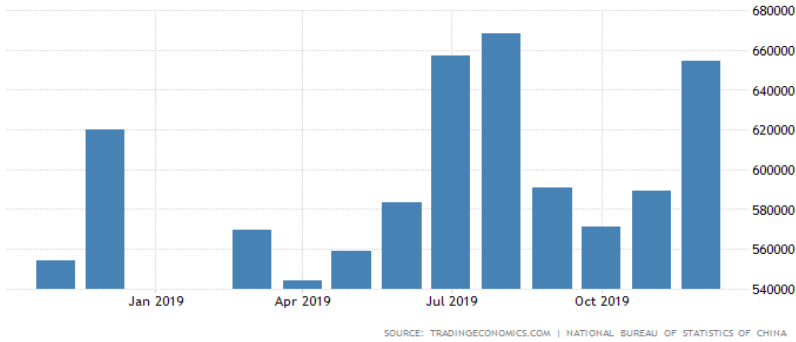
China has developed a ten-year plan aimed at increasing its structural capacity in several renewable energy sectors. These goals are:

- * Increasing the ability to heat water using solar energy to 1.1 million cubic meters.
- * And raising the cumulative production capacity of solar cells to 5.3 megawatts.

To achieve these goals in 2003, the state: (Peter Meisen, 2017)

- Enacting the Renewable Energy Promotion Act;
- Regulating incentive policies in law to encourage renewable technology;
- Providing market opportunities for renewable energy companies to allow local governments, institutions and individuals to promote and use renewable energies.

In general, the tenth five-year plan succeeded in promoting renewable energies by increasing the electricity production during 2019 (as shown in Figure 5).

Fig.5. China Electricity Production in 2019

Source : <https://tradingeconomics.com/china/electricity-production>

- Twelfth Five-Year Plan

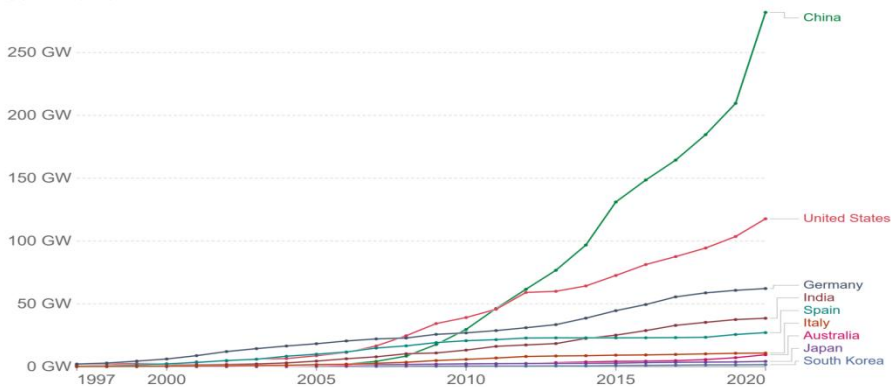
The rapid growth of renewable energies was the result of the 2005 law on renewable energies, and China was one of the first to devote laws to renewable energies, as this law began operating in 2006 and laid solid foundations to achieve the goal of increasing the capacity of renewable energies to supply 15% of energy needs in 2020. On this basis, China has adopted the following measures:

Establishment of large wind stations (capacity ranging from 5-10 MW) in the northern, northeast and northwestern regions. (Gao, 2010)

- Developing the productive capacity of marine winds.
- Building new cities for renewable energy.
- Building solar stations in desert areas.
- Development of green district plans.

And the following table shows the wind energy in China in 2021:

Fig 6. Wind Power in China in 2021



Source: Statistical Review of World Energy, BP (2021)

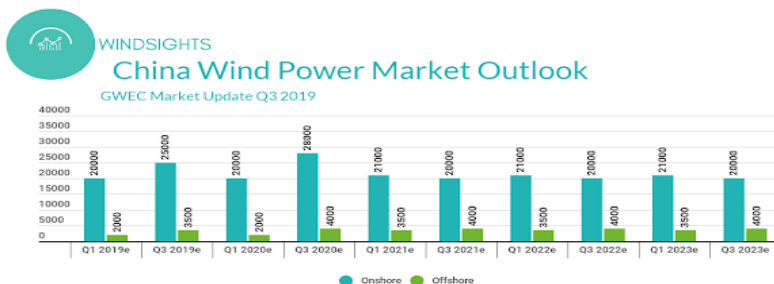
China will reach 437,000 megawatts of total wind energy capacity by 2028, according to independent research firm Wood Mackenzie.

The country is expected to add 25,000 MW of annual wind turbines capacity from 2019 to 2028.

Onshore developments will account for 84% of new additions and will receive the same tariff as coal-fired power beginning in 2021, following governmental efforts to reach grid parity. (Wang, 2009)

“Developers are using the window before this deadline to rush to complete subsidized projects, which will boost capacity additions to 28,000 MW in 2020,” (with Wood Mackenzie Power and Renewables).

Fig.6. China Wind Power Market Outlook



Source: <https://www.evwind.es/2019/09/12/china-wind-power-capacity-to-reach-437000-mw/70806>

Most of the new wind farm capacity will be located in China's wind-rich northern region, where 21 out of 22 new bases will be located. Inner Mongolia alone will host 46,000 MW of developments. The price premium in the northern region will be up to 70%, due to low coal prices.

Developers may face massive losses in 2021 and 2022 and will not be willing to develop wind projects on a large scale". "China do not expect averaged national onshore wind power project costs to reach grid parity with coal-fired power until after 2023."

7. China's Financing of Renewable Energies

The Chinese government funded renewable energies through the Bloomberg Report, and it obtained this funding from several sources, including:

- Public banks offer them relatively low-cost debt for renewable energy projects, such as the China Development Bank.
- In 2010, the Chinese government extended \$ 36 billion in loan guarantees to renewable energy companies.
- **Organized loans and bond issuance:** Obtaining this type of low interest rate loan from public banks helped support extraordinary levels of expansion in the deployment of renewable energies.

China has been interested in attracting FDI and converting it into renewable energy projects, and its 2002 program encouraged the construction and running of renewable energies. In 2011, the program encouraged foreign investment in technology, green industries and wild wind energy.

That's why, in 2019, the World Bank's Board of Executive Directors have approved a US\$300 million loan for the China Renewable Energy and Battery Storage Promotion Project to increase the integration and utilization of renewable energy by deploying battery storage systems at scale.

Despite having the largest installed electricity generation capacity of wind and solar power, China is unable to operate and utilize these resources fully due to technical constraints in the transmission networks and gaps in the regulatory framework for electricity trade between provinces. This project will help address these constraints and support China's overarching energy transition goals. These include a shift away from coal and increasing the

share of non-fossil fuels in the primary energy consumption from the current 14.3% to 20% by 2030, and to over 50% by 2050.

This project will help accelerate the on-going clean energy transition in China and contribute to the country's emission reduction targets," said Martin Raiser, World Bank Country Director for China. "By providing financing for battery storage and distributed renewable energy applications, the project will reduce curtailment of renewable energy capacity and thus encourage further investments into changing China's energy mix. Parallel technical assistance will help improve the policy and regulatory framework for green energy technologies, thereby reducing risks and encouraging private investment.

The Renewable Energy and Battery Storage Promotion Project will be implemented by Hua Xia Bank, a publicly listed commercial bank in China. Hua Xia Bank will provide co-financing of at least \$450 million to achieve the development goals of the project. Technical assistance for policy and regulatory reforms, shaping appropriate technology and safety standards, and developing institutional capabilities will be financed by the Global Environmental Facility (GEF) and the Energy Sector Management Assistance Program (ESMAP).

8. CONCLUSION

The development of mechanisms and procedures for financing and developing renewable energy projects requires determining the most appropriate means available at the national or regional level that include the level of technical maturity, the availability of appropriate capital, and local renewable energy resources, as well as the diversity of economic mechanisms represented in financial and fiscal incentives such as tax deductions, Public financing policies such as low-interest loans, and regulations and regulations such as quantity-based policies such as public tenders, quotas, and price-based policies.

China, like other countries, set out in the field of investment and production of renewable energies, but it managed to rank first in the world, surpassing the United States of America, Germany and Japan.

8.1 Results

- China plans to provide half of its energy by 2050 from renewable sources, the year when many countries aim to completely eliminate carbon emissions, in either case wind will be the key word.
- China's size and population of 1.4 billion means that a huge amount of renewable energy is being generated, even though a lot of carbon dioxide continues to be circulating in the atmosphere.
- Despite global criticism of China for its extensive use of coal, which remains the mainstay of the Chinese economy, there are signs that it is slowly giving way to renewable energy sources.

8.2 Recommendations

- The necessity of investing in the renewable energy sector.
- The importance of setting realistic policies to advance goals and objectives, and setting a time limit for their implementation and support by governments.
- Carrying out many complete and homogeneous reform processes in order to develop the renewable energies sector.
- Adopting renewable energy support policies while choosing the appropriate policies.

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